Alberta

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RENEWABLE ENERGY TOOLKIT for Economic Development

Government of Alberta

Finance and Enterprise

Renewable Energy Toolkit for Economic Development
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INTRODUCTION TO THE TOOLKIT

HOW TO USE THE RENEWABLE ENERGY TOOLKIT FOR ECONOMIC DEVELOPMENT

Renewable Energy Toolkit for Economic Development has been prepared by Alberta Finance and Enterprise to assist communities, to evaluate the potential benefits and risks of renewable energy projects that may provide new economic development opportunities. The Toolkit is designed as a "Self-Assessment" aid that can be used by communities, groups of communities or regions and be integrated with their own economic development structures and strategies. It can be used in a logical sequence working through all of the elements indicated below or simply as a reference for specific planning aspects.

Although the Toolkit attempts to be as complete as possible in suggesting issues that communities need to consider, it is recommended that additional assessments also be considered before deciding move ahead with any renewable energy project. Each community will need to determine the level of due diligence and additional resources needed for project development.

WHAT IS THE PURPOSE OF THE TOOLKIT?

The purpose of this Toolkit is three-fold:

A. **UNDERSTANDING** - To aid communities in understanding the basics of renewable energy and the types of projects.

B. **COMMUNITY READINESS** - To aid communities in being ready to consider renewable energy projects before specific projects have been presented.

C. **PROJECT SCREENING** - To aid communities in the first level of screening or evaluation of projects, when such projects are presented to them.

WHAT DOES THE TOOLKIT CONTAIN?

The Toolkit contains 13 elements. The first is the Community Action Template for Renewable Energy which provides a suggested sequential approach in using the Toolkit, referencing the other 12 elements.

The 12 elements are organized based on the purpose of the Toolkit:

A. **COMMUNITY UNDERSTANDING AND LEARNING**

- An Overall Profile of Renewable Energy
- A list of the 24 main types of renewable energy projects
- Six profiles of the main sources of renewable energy

B. COMMUNITY READINESS

- CHECKLIST 1 - A Strengths and Weaknesses Checklist to assist communities in determining "best fit" for renewable energy project types for their community
- CHECKLISTS 2 TO 5 – Checklists for Community Receptiveness; Community Capacity; Environmental and Social Impacts; and, Investment Readiness

C. PROJECT SCREENING

- CHECKLISTS 6 TO 9 – Checklists for Developer Viability; Technology; Community Benefit and Developer Business Plan; and, a final Reality Check

WHAT THE TOOLKIT IS NOT

The Toolkit is not a "recipe" for the development of renewable energy projects. It provides a framework that should be used in conjunction with other sources of information and assistance as well as additional resources provided by the network of Alberta Government departments, including:

- Alberta Agriculture and Rural Development
- Alberta Energy
- Alberta Environment
- Alberta Finance and Enterprise
- Alberta Municipal Affairs
- Alberta Sustainable Resource Development

Other agencies, such as Alberta Innovates – Bio Solutions and the Biorefining Conversions Network, can also provide useful direction.

The Toolkit is not meant to be an "advocate" of particular renewable energy projects. Each community that is considering an economic development opportunity must do its own full due diligence to ensure that the particular project is the right fit for the community, its businesses and its residents.

Finally, the Toolkit is not a source of information on existing or proposed policies or incentives of the Government of Alberta with respect to renewable energy development. Such information needs to be fully current and should be accessed independently of the Toolkit.

COMMUNITY ACTION TEMPLATE FOR RENEWABLE ENERGY

The ***Community Action Template*** provides a suggested sequential set of steps in using the other 12 elements of the Toolkit.

The level of understanding and readiness will vary by community and so the process of using the Toolkit should be adapted to each potential user's needs.

For understanding and learning, some communities or regions may already have developed their own renewable energy publications which should be used in conjunction with the Profiles of the Toolkit. Some communities may have already moved further ahead with community readiness and will only need to use the Investment Readiness Checklist as a "double-check" of their level of preparedness to consider projects. Some communities will already be in the phase of project development and may have already developed a process of project screening, in which case the Checklists provided here will simply provide a point of comparison.

A.

COMMUNITY UNDERSTANDING AND LEARNING

Step	Description	Content	Toolkit Element
A.1	Review the basics of renewable energy	Generation of electricity; Production of heating and cooling; Production of biofuels; Key drivers of Renewable Energy; Contribution to economic development; Community role	Overall Renewable Energy Profile
A.2	Understand the main types of renewable energy projects	24 main projects described with Alberta examples	Types of Renewable Energy Projects
A.3	Review the individual renewable energy profiles.	Wind for electricity generation; Solar PV for electricity generation; Enhanced Geothermal for electricity; Bioenergy and Combined Heat and Power (CHP); Heating and cooling use solar thermal, geothermal heat pumps and bioenergy boilers; Biofuels and Biorefineries	6 Profiles with referenced websites for further information

B.

COMMUNITY READINESS

Step	Description	Content	Toolkit Element
B.1	Conduct Community Strengths and Weaknesses analysis to determine which types of renewable energy projects might be the best fit for your community or region.	Input from General Public and Civic Groups; Business Community; Municipal Government Leaders; Educational and Research Institutions	Checklist B.1 Strengths and Weaknesses Analysis
B.2	Ensure Community Receptiveness to renewable energy project development.	Input from General Public and Civic Groups; Business Community; Municipal Government Leaders; Educational and Research Institutions	Checklist B.2 Community Receptiveness
B.3	Assess your community capacity for renewable energy projects.	Organizational; Development Strategy; Support Programs; Land Use and Availability, Utilities, Transportation and Communications; Feedstocks for Bioenergy; Human Resources	Checklist B.3 Community Capacity
B.4	Assess the potential environmental and related impacts of renewable energy development in your community.	Emissions and site contamination; Biodiversity Protection; Worker Health and Safety; Public Opinion	Checklist B.4 Environmental and Social Impacts
B.5	Assess the Investment Readiness of your community for renewable energy projects. This builds on the Community Capacity and Environmental and Social Impacts Checklists and provides a final checklist to ensure that you are ready to move forward with screening of specific renewable energy projects -	Review Community Receptiveness, Capacity and Environmental and Social Issues; Consider other issues such as Active Business Recruitment, Local Investment Capacity.	Checklist B.5 investment Readiness

C.

PROJECT SCREENING

Step	Description	Content	Toolkit Element
C.1	Screen the reputation and viability of any developer who approaches the community with a project proposal.	Corporate Information; Project History; Project Elements; Project Financing; Type of Agreement	Checklist C.1 - Developer Viability
C.2	Screen the renewable energy technology that a developer is proposing to use.	Technology Readiness; Output of the Technology; Technology Requirements; Operational Performance; Components Supply; Feedstock Supply	Checklist C.2 - Technology
C.3	Before moving forward with a project, screen it against the background of the Community Benefit and the elements that should be addressed in the Developer's Business Plan.	Community Benefit; Technical Feasibility; Management Feasibility; Economic Feasibility; Market Feasibility; Financial Feasibility; Environmental Feasibility	Checklist C.3 - Community Benefit and Developer Business Plan
C.4	Before proceeding with an agreement do a "Reality Check" to ensure that you are satisfied with the due diligence that you have undertaken to ensure a successful project outcome.		Checklist C.4 - Reality Check

A.1

OVERALL PROFILED OF RENEWABLE ENERGY

Conventional energy in Alberta is energy that comes from oil, natural gas and coal – the fossil fuels. The Province is rich in these sources of energy. In other countries (e.g. France) where nuclear energy is used extensively, it would be included in "conventional".

Alternative Energy is defined as anything that is not "conventional". So, for Alberta, wind, solar, biomass, geothermal, hydro, peat, sewage sludge, manure and municipal solid waste (MSW) can be added to the list. As technologies advance, other Alternative Energy sources will emerge, such as hydrogen fuel cells.

Renewable Energy is a narrower concept. It includes all sources of energy that, if used, can be "renewed" and never fully "used up". Solar, geothermal and wind energy are really unending sources and humans do not really have to do anything to "replace" them[1]. Bioenergy from agriculture and forestry is only renewable if humans actively grow and replace the biomass that is used in energy production. Biomass waste such as sewage sludge, manure and MSW can be considered renewable if it is organic (i.e. plant waste rather than fossil-based plastics etc.).

Renewable energy will not replace conventional energy in the short or even medium term. The demand for oil, natural gas and coal will continue well into the future and will continue to be the predominant source of energy in Alberta, Canada and the world for many years to come. 75% of Canada's primary energy comes from these fossil fuels. The International Energy Agency (IEA) forecasts that – even in the optimistic scenario - supply from these fossil fuels would decline from 82% in 2007 to 67% by 2030.

Renewable energy can replace fossil fuels but, at present, is used primarily in a "complementary" fashion to fossil fuels. For instance, electricity that is fed into the Alberta grid is predominantly fossil-fuel based but is supplemented by electricity from renewable sources such as wind farms. Ethanol is used as a blend with gasoline. Renewable energy heating systems often have a fossil-fuel based backup system.

HOW CAN RENEWABLE ENERGY BE USED?

This Toolkit provides profiles of the main sources and uses of Renewable Energy

- Wind energy for electricity
- Solar photovoltaic (Solar PV) energy for electricity
- Enhanced geothermal energy for electricity
- Bioenergy for electricity and combined heat and power (CHP)

[1] Hydro power (electricity generation from flowing water) is also considered to be renewable energy. While hydro power is not prominent in Alberta, it is in other provinces such as Ontario. In Ontario, since it has been part of the standard energy mix for a considerable length of time it can also be considered as "conventional" energy.

- Heating and cooling using solar thermal energy, geothermal heat pumps and bioenergy boilers
- Biofuels (for transportation) and biorefineries

The world's most significant use of energy is for heating and cooling purposes (about 50% with 20% for electricity and 30% for transportation).

Wind, solar PV and geothermal energy can be used for the production of electricity. Solar thermal panels, geothermal heat pumps and bioenergy boilers can be used to produce heating and cooling.

In addition, bioenergy can be used to produce transportation fuels (biofuels) and can be further processed in a "biorefinery". A biorefinery – which is just beginning to come on the scene - is a facility that integrates biomass conversion processes and equipment to produce a range of foods, fuels, chemicals, feeds, materials, heat and power in proportions that maximize economic return (similar to today's petroleum refineries).

Generation of Electricity from Renewable Energy

The demand for electricity in Alberta is growing rapidly, creating possible opportunities for new generation projects.

An electricity grid transmission system ensures that people throughout a jurisdiction have access to electricity no matter where the generation occurs or how it is produced. In many provinces of Canada, the grid is owned and managed by the provincial government. However, in Alberta no part of the system is owned by the government. Alberta's grid is a mixture of privately and municipally-owned facilities. The electricity marketplace supports electricity generation from many different power sources. Producers choose which type of fuel and technology will be used to provide electricity supply. Since 1998, generation from renewable resources (including hydro) has increased by 63%[2]. A key factor in developing power from renewable energy is the ability to connect to the grid.

Alberta's electricity system is a network of generation facilities, transmission lines, wholesalers/ retailers and regulators. The key players are:

- The Alberta Electric System Operator (AESO) which is independent from the government and is responsible for system planning, such as critical transmission infrastructure projects. The AESO operates in the public interest in accordance with the Electric Utilities Act.
- The Alberta Utilities Commission (AUC) which regulates the utilities sector, natural gas and electricity markets to protect social, economic and environmental interests. It regulates the transmission of electricity and is responsible for making decisions about

[2] This section is based on several Alberta Energy publications such as "Electricity and You", and "Talk about Alberta's regulated electricity transmission system" available at www.energy.alberta.ca

transmission facilities and lines. All new generation projects must be approved by the AUC. However, own-use electricity generation is exempt from the system.

- The Independent System Operator, part of the AESO, which ensures an open-access, competitive market place.

Grid-connected electricity can come from wind power, solar photovoltaic power, geothermal power and bioenergy (including biogas). Wind power is the most commercially developed renewable electricity source in Alberta.

Production of Heating and Cooling from Renewable Energy

Heat is required for space heating in buildings and for process heat to drive equipment in industry.

In Canada, 70% of energy used in residential, commercial and institutional buildings is used for heating.

Renewable energy can be used to generate electricity which can, in turn, provide heating, cooling and lighting. But solar thermal, geothermal and bioenergy can be used directly to produce space heating, hot water and cooling for individual homes, commercial or institutional buildings, for groups of buildings and for entire communities (district heating and cooling). This is referred to as "low heat" that is under 180 degrees Celsius.

Some jurisdictions – in particular Europe – intend to phase out fossil fuel energy sources for new buildings and are already making a certain percentage of energy from renewables mandatory.

At the same time, many are working on making buildings more efficient users of energy and are developing ways to "integrate" renewables into the structure and cladding of buildings. By 2030, buildings may be the most prominent focus for renewable energy systems.

Production of Biofuels

Transportation is the single largest source of Greenhouse Gas Emissions (GHG's) and demand for fuel is expected to grow more rapidly than any other sector up to 2020. Thus replacing or blending fossil fuels with biofuels is a priority in most countries. The main biofuels are biodiesel and ethanol. Biogas is also treated as a biofuel although it can also be used to produce heat and electricity. The biomass used for biodiesel and ethanol is predominantly agricultural (canola, sunflower, tallow for biodiesel; corn, wheat, and sugarbeets for ethanol). The main Alberta biofuel sources are wheat and canola. Biogas is mainly produced from landfill sites and from animal and food processing wastes.

Second-generation biofuels are those that can be produced from ligno-cellulosic materials which includes both forest and agriculture feedstocks. Plant demonstrations of the technologies involved are underway,

Ligno-cellulosic biofuels come from a wider variety of non-food feedstocks, provide greater environmental benefits and will eventually be cheaper to produce than current processes. Examples of second generation feedstocks are switchgrass, camillina, willow and wood chips. Canada is a leader in second generation ethanol technology.

Biofuels is the most common pathway to biorefineries, but equally important is the expansion or conversion of pulp mills to biorefineries.

WHAT IS DRIVING RENEWABLE ENERGY?

The key drivers of renewable energy development are the following:

Conventional Energy is Ultimately Finite

Conventional energy sources are finite and will eventually be depleted, even if this is far in the future. They are only renewable through millions of years in the evolution of the earth. But with continuously growing energy demand, new sources of energy must be developed. Renewable energy can contribute to meeting this growing demand.

Sustainability

There is a growing commitment at individual, community, national and global levels to ensure that development activities are undertaken in a sustainable manner. A significant contributor to this effort is the development of energy sources which are renewable and can contribute towards a balanced energy future. The use of solar, wind, geothermal and biomass as energy sources work towards achieving this balance.

From an industry point of view, renewable energy holds the potential to open up new sources of employment through the development of "green" industries in Alberta. This is particularly true in light of the provincial expertise in the areas of agriculture, forestry and petrochemicals. As well, this emerging sector of the economic presents opportunities for international investment opportunities within Alberta.

HOW CAN RENEWABLE ENERGY PROJECTS CONTRIBUTE TO ECONOMIC DEVELOPMENT?

Countries of the European Union have set a binding target of a 20% share of renewable energy by 2020. In Europe renewable energy technologies already have sales of nearly $30 billion annually and are estimated to provide over 300,000 jobs. One million jobs are expected by 2020[3], a significant number of which will be in rural areas.

Similar economic development opportunities can emerge for Canada and for Alberta, particularly for communities with abundant forest and agriculture resources. Alberta is fortunate within

[3] Commission of the European Communities – COM (2008) 30 final

the Canadian context to have expertise[4] within the fossil fuel industries and in petrochemical processing that can be used to leverage new renewable opportunities in partnership with new renewable technology partners.

One pathway of economic development opportunities from renewable energy can be characterized as follows:

- Initiation of projects that use renewable energy technology and equipment, perhaps initially from outside Alberta.
- Initiation of demonstration projects by investors and local communities based on the resource and expertise advantages of Alberta.
- Opportunities for local installation, maintenance and professional services such as engineering and project management.
- Local manufacturing of components for renewable energy equipment.
- Further research in Alberta on how improvements to processes and equipment can be made, particularly based on the provinces expertise in oil, gas and coal as well as forestry and agriculture.
- Design and manufacturing of components and full renewable energy systems.
- Based on expertise gained in design, installation and project management, export of systems and services to other jurisdictions.

WHAT IS THE ROLE OF COMMUNITIES?

For larger renewable energy projects communities will act as hosts to private sector investment. They may in some cases be part of a formal, legal partnership with a private sector developer or a consortium of developers. However, the more common case is that the community (municipal corporation) will be part of an informal partnership. This means that an understanding will be reached with a developer with respect to the provision of certain municipal infrastructure services, land and/or other professional services. The community may also act as a facilitator for the developer in accessing government-based incentive programs.

For the successful implementation of a project, the partnership should be as open and strong as possible with full knowledge of the expectations and obligations of each party within a defined time-line.

In other cases, usually smaller projects, the community (municipal corporation) may act as a renewable energy project initiator. This could happen, for instance, with the development of a district energy system or the application of renewable energy to specific municipal buildings. But even in these cases, the community may still entrust the operation of an initiative to a private sector company or to a local cooperative (common model for district energy in Europe).

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4 As an example, for every 500 people in the labour force in Alberta, 8.4 are Engineers. This is the highest ratio of all Canadian Provinces - 6.1 in Ontario and 4.7 in each of Quebec and British Columbia. (Source: derived from Statistics Canada 2006 Census data). The situation is similar for other technical occupation categories, such as geologists.

In all cases, the spirit of a renewable energy project that is going to be successfully implemented in a community is an active partnership between all of the key players – from both the private and public sectors.

A.2

TYPES OF RENEWABLE ENERGY PROJECTS

Following is a list of the twenty four major types of renewable energy projects organized under the headings of the six Awareness Profiles for sources and uses of renewable energy. The key factors for successful implementation are listed along with examples of communities in Alberta where projects have been initiated. Projects in communities may focus on one type of renewable energy source but generally the aim is to develop projects from several renewable energy sources that can act in a complementary fashion to create "renewable energy clusters". The list is presented to assist communities and should not be considered as a complete list of all project considerations.

	TYPE OF PROJECT	KEY FACTORS	EXAMPLES OR POTENTIAL
WIND FOR ELECTRICITY PRODUCTION			
1	Small-scale for own use	• Sufficient wind speed • Moderate investment • Batteries for storage	◦ *Several examples throughout Alberta*
2	Commercial wind farms	• Sufficient wind speed • Grid connection essential • High investment • Technology is commercially ready	◦ *Many wind farms in Southern Alberta – may be local opportunities in other regions*
SOLAR PHOTOVALTAIC (PV) FOR ELECTRICITY PRODUCTION			
3	Off-grid residential and commercial application	• Sufficient sunlight • Batteries for storage	◦ *Applicable to remote areas with no or limited grid connection*
4	Off-grid communications application *(telecom relays, navigational aids etc.)*	• Sufficient sunlight	
5	Grid-connected single or multiple buildings	• Sufficient sunlight • Grid connection essential but not generally a problem • Technology is commercially ready	◦ *Alberta Solar Municipal Showcase* ◦ *Vulcan County farm* ◦ *Potential opportunities throughout Alberta*
6	Centralized Photovoltaic (PV) power plants	• Sufficient sunlight • Grid connection essential and not available everywhere • Technology is commercially ready	◦ *No examples so far, but potential for development*

	TYPE OF PROJECT	KEY FACTORS	EXAMPLES OR POTENTIAL
ENHANCED GEOTHERMAL FOR ELECTRICITY PRODUCTION			
7	Geothermal that taps into reservoirs of hot water and steam in the ground	• Thermal reservoirs	◦ *Only sites are within boundaries of Jasper National Park and Banff National Park (not available for development)*
8	Enhanced deep wells for power plants	• Technology not yet commercial • Closeness to "hot spots" desirable • Grid connection essential • Link to oil and gas industry drilling technology • High investment	◦ *No projects so far* ◦ *Potential to use end of life oil/gas wells or coal mines* ◦ *Potential to combine with carbon capture*
BIOMASS FOR ELECTRICITY PRODUCTION - And Combined Heat and Power (CHP)			
9	Industrial CHP systems that use heat directly for industrial processes and supply electricity to the grid	• Conversion or enhancement of pulp and paper operations • High investment	◦ *Forest product-based facilities in Drayton Valley, Whitecourt and Grande Prairie* ◦ *Others proposed* ◦ *Other industries proposed or considering*
10	Dedicated biomass power plant	• Generally uses wood chips, wood pellets and Municipal Solid Waste (MSW)	◦ *Examples in USA and Europe* ◦ *Gasification facility in Dapp*
11	Biomass co-fired power plant *(e.g. with coal)*	• Technology well-developed and easily applied • Needs coal fired power plant owner/operator to take lead	◦ *Common in Europe* ◦ *No examples so far in Alberta, but potential development*
12	Waste-to-energy that uses biomass, municipal solid waste(MSW) and garbage	• Technology is commercially ready	◦ *Common in Europe* ◦ *Red Deer with 20 other municipalities awaiting building of gasification plant to handle MSW* ◦ *Edmonton building gasification plant to handle MSW* ◦ *Southern Alberta Energy-from-Waste Alliance*

	TYPE OF PROJECT	KEY FACTORS	EXAMPLES OR POTENTIAL
13	Pellet production (most of Canada's production exported to Europe for electricity generation)	• Requires access to wood biomass • Technology is commercially ready • High investment for larger plants	◦ *Plants in Slave Lake, La Crete and Grande Cache*
HEATING AND COOLING			
14	For individual or several residential and commercial buildings	• Suitable buildings • Investment moderate • Technology is commercially ready	◦ *Opportunities throughout Alberta*
	Solar hot water	• Suitable sunlight • Technology is commercially ready	◦ *Drake Landing Solar Community* ◦ *Turin Hutterite Colony*
	Geothermal heating and cooling	• Moderate investment • Technology is commercially ready	◦ *General applicability in Alberta*
	Biomass heating	• Wood pellets or wood chips • Technology is commercially ready	◦ *Common in Europe and some parts of USA*
15	District heating and cooling	• Density of buildings and residences to reduce pipe needs • Usually initiated by municipality • Uses wood pellets or wood chips • Moderate to high investment	◦ *Systems common in Europe* ◦ *District energy systems exist in Alberta (Calgary) but are not biomass-based*
BIOFUELS – And Biorefineries			
16	Biodiesel *(small)*	• Access to biomass • Moderate investment	◦ *Operation in Barons based on used cooking oils*
17	Biodiesel *(commercial – first generation)*	• Access to biomass (tallow and canola most in use) • Access to water for processing • Technology is commercially ready	◦ *Plants at Aldersyde and Lethbridge*

	TYPE OF PROJECT	KEY FACTORS	EXAMPLES OR POTENTIAL
BIOFUELS – And Biorefineries (cont'd)			
18	Ethanol *(commercial - first generation)*	• Access to agriculture biomass (wheat and triticale most in use as well as imported corn) • Access to water for processing • Technology is commercially ready	◦ *Plant at Red Deer* ◦ *Applicable wherever agriculture biomass available*
19	Ethanol *(commercial - second generation)*	• Technology not fully commercially ready • Access to water for processing • Access to biomass (wood based)	◦ *Drayton Valley gasification* ◦ *City of Edmonton (proposed gasification)* ◦ *Applicable wherever wood biomass available*
20	Biogas *(commercial)*	• Access to biomass *(mainly manure and food processing wastes)*	◦ *Iron Creek Hutterite Colony* ◦ *Others proposed*
21	Pyrolysis oil	• Technology emerging for wood biomass to energy	◦ *No projects yet in Alberta and still limited application elsewhere*
22	Tarped sewage lagoons fueling boilers	• At conceptual stage	◦ *No sites yet in Alberta*
23	Biorefinery biofuel pathways	• Complex projects • Substantial investment required • Not yet widespread application	◦ *Hairy Hill project combines ethanol, biogas, heat production, electricity production, and organic type fertilizers*
24	Biorefinery pulp pathways	• Emerging but substantial opportunities	◦ *Several pulp and paper operations in Alberta considering projects*

What about wind for electricity?

Wind energy is the fastest growing renewable energy source throughout the world with installed capacity doubling every three to five years. It is also the most rapidly deployable. The leading countries in installed capacity are Germany, United States, Spain, India and China. In Denmark, wind supplies over 20% of total electricity demand.

Canada's first commercial wind farm was built at Cowley Ridge, Alberta in the early 1990's. Southern Alberta is one of the strongest wind power regions in Canada with many wind farms now established and others proposed. Installed capacity in 2009 was over 500 MW providing 4% of Alberta's electricity needs (from "Talk about Wind Power", Government of Alberta).

HOW DOES IT WORK?

Everyone is familiar with windmills. The wind turns the blades creating mechanical power. A modern wind turbine directs mechanical power to a turbine to produce electricity.

HOW IS IT USED?

While single wind turbines can be installed with the electricity used locally and directly, the usual configuration is a wind farm with multiple turbines supplying electricity to the Alberta electrical grid. The mid-size range of a farm is 20 to 50 MW. Some very large farms in United States are over 500 MW. The investment required is $1.5 million to $2 million per MW installed. Turbines are getting larger and taller, more efficient and with generally declining investment costs per MW.

As wind blows intermittently, not all of the installed capacity is used on a continuous basis. Electricity generation is between 25% and 35% of installed capacity. At 35% efficiency, one MW produces enough electricity for 300 homes, with each home using about 10 Megawatt-hours (MWh) per year (not including electric heating).

Intermittency can be addressed through energy storage systems and complimentary electricity system to supplement wind generation.

HOW DOES IT CONTRIBUTE TO ECONOMIC DEVELOPMENT?

The installation of wind-power often leads to expertise in technology development and component manufacturing capability. The large European turbine manufacturers are establishing facilities around the world. As each turbine has over 8,000 components, the supply chains are extensive.

Manufacturing opportunities can include control systems, generators, castings, towers, blades, bearings and gearboxes. A wind farm also requires installation (foundations and towers) as well as ongoing maintenance and repair. Local expertise can also be built up in services such a legal, financial and engineering.

The local human resource skills required are in relation to the installation, maintenance and repair of wind turbines. Lethbridge College is the Canadian leader in wind turbine technician and teacher training certification.

WHO ARE THE PLAYERS IN ALBERTA?

"Harness the wind of Southern Alberta", a publication by the Southern Alberta Renewable Energy Partnership (SAAEP) notes:

- Major wind generators/developers in the region include TransAlta Wind, Enmax, Suncor Energy and Enbridge Inc.
- Equipment suppliers from international manufacturers such as Acciona Windpower (Spain), Vestas (Denmark), GE Wind (USA) and Enercon (Germany).

WHAT NEW TECHNOLOGY IS COMING?

The research and development focus for the future is on;

- New turbine designs with the use of new materials (enabling turbines to turn more slowly and more efficiently).
- Component manufacturing processes and mass manufacturing (to meet the growing demand).
- Best methods of grid integration (to enable growth in wind power).
- Battery storage systems

WHAT RESOURCES ARE NEEDED?

Wind energy projects require

- Locations with sufficient wind speed – usually 18 km/hour or more.
- Proximity to the Alberta electricity grid and the regulatory authority to integrate into the grid.

In Alberta, as in many other jurisdictions, the limiting factor on the growth of wind power is the capacity of the electricity grid to accept more hook-ups. However, Alberta is planning for an additional 4,000 MW of wind power by 2020 and undertaking a multi-billion dollar grid upgrade, mostly in the southern region. The Southern Alberta Renewable Energy Partnership (SAAEP) estimates that 11,500 MW of "wind interest" applications are in the pipeline throughout Alberta. In 2008 the Alberta Government introduced a micro-generation regulation allowing small wind turbines to sell excess electricity into the grid.

Projects do not use any local natural resources other than wind and land. They do not need water.

HOW DO PROJECTS GET STARTED?

The initial task in moving a wind energy "idea" forward is to ensure a suitable site with adequate wind and to ensure that connection to the grid will be permitted at that site.

The Canadian Wind Association suggests the following eleven steps in moving a wind power project forward. The steps can require 12 to 36 months to complete and would be undertaken by a project developer/investor with assistance from local partners.

1. Wind assessment
2. Farm design
3. Environmental study
4. Land acquisition
5. Permitting and public consultation
6. Economic and financial analysis
7. Manufacturing
8. Site preparation
9. Construction
10. Commissioning
11. Operation and maintenance

WHAT ABOUT THE ENVIRONMENT?

The overall environmental impact is very positive as electricity production from wind power is clean with no emissions, particularly so when compared to electricity from coal or natural gas.

Public reaction to the development of wind power projects can vary significantly by location. Social acceptance is crucial for successful development.

The siting of the wind farm is the most important element in limiting the environmental impact. The type, size and speed of the turbines used are also important. The main concerns that have come to light include:

- Visual impact (need to consider impact up to 10 km range and particularly within first 2 km)
- The perceived noise impact from the aerodynamic movement of the blades
- The use of the land on which the turbines are situated and incompatible competing uses
- Impact on birds, bats and wildlife habitat
- Potential electromagnetic interference

WHERE TO GET MORE INFORMATION

1. Alberta Energy www.energy.alberta.ca
2. Southern Alberta Renewable Energy Partnership www.saaep.ca
3. TransAlta Corp. www.transalta.com
4. Canadian Wind Energy Association www.canwea.ca
5. Wind Energy Institute of Canada www.weican.ca
6. Canadian Wind Energy Atlas www.windatlas.ca
7. The Global Wind Energy Council www.gwec.net
8. European Wind Energy Association www.ewea.org
9. American Wind Energy Association www.awea.org

What about Solar Photovoltaic (PV) for electricity?

A solar photovoltaic (PV) cell converts the sun's energy into electricity by causing a voltage flow between the positive and negative layers of the cell.

About one-half of the world's 14,000 MW of PV energy is installed in Europe and one-half in the rest of the world.

The leading PV power countries are Germany, Spain, Italy, United States, Japan and Korea. In Europe, about 3% of the total electricity supply is expected to come from PV by 2020.

Canada is far down the list with only 33 MW installed at the end of 2008. Nevertheless, annual growth is impressive and Ontario, with its Green Energy Act (October 2009) and generous feed-in tariffs has become one of the fastest growing PV markets in North America. Feed-in tariffs provide a guaranteed, subsidized purchase price for renewable energy electricity.

The application of PV systems in Alberta is growing, particularly in the grid-connected distributed market.

HOW DOES IT WORK?

PV cells are made of a semi-conducting material, generally silicon. When the cell is exposed to the sun, the photons generate electrical charges inside the material.

HOW DOES IT CREATE POWER?

A PV module is made up of many individual PV cells. Modules are normally connected together to form a PV array. The modules produce direct current (DC) which is turned into alternating current (AC) by an inverter. The modules, inverter and all ancillary control and management equipment make up the PV power system. Systems can also incorporate storage batteries.

PV power systems have no moving parts. They are silent, require only minimal maintenance and are often self-cleaning. More power is generated when the sun shines brightly but modules will still generate some electricity on overcast days.

As the sun shines only intermittently, not all of the installed capacity is used on a continuous basis. Intermittency can be addressed through energy storage systems and complimentary electricity system to supplement solar generation. Battery technology development will be important in the future.

For a system with a rated power of 1 kW in Alberta, the actual electricity production would range from 600 kWh to 1,000 kWh per year depending on the amount of sunlight available and the technology used – 7% to 23% efficiency. The practical limit of conversion efficiency is about 30%.

WHERE IS THE TECHNOLOGY USED?

The most common technology is wafer based crystalline silicon, as normally seen on rooftop panel systems. With "thin film" technology, which is growing fast, modules are constructed by depositing extremely thin layers of semi-conductor materials onto a backing such as glass, stainless steel or plastic.

Concentrating PV (CPV) and dye-cells are also emerging technologies.

GRID-CONNECTED AND OFF-GRID

Two main PV market segments exist: Off-grid systems with no grid connection and Grid-connected systems.

The market initially developed with off-grid systems and, in Canada, 85% of capacity is off-grid. However, the grid-connected market has shown growth of 40% annually since 2000 and will increasingly be the focus of attention. In the USA, nearly 90% of the market is grid-connected.

OFF-GRID SYSTEMS ARE:

- Domestic systems for individual homes or other buildings or for rural application where no grid exists.
- Non-domestic systems used for single applications in telecommunication relays, water pumping, navigational aids and highway information panels.

GRID-CONNECTED SYSTEMS ARE:

- Distributed systems including single or multiple buildings that can provide electricity to the grid and use electricity from it. This includes Building Integrated PV systems (BIPV).
- Centralized PV power plants, whose sole objective is to provide electricity to the grid, in a size range of 10MW to 100 MW.

The grid-connected distributed systems are likely to be the growth focus for Alberta. Howell-Mayhew Engineering of Edmonton estimates 100 grid-connected systems on buildings in Alberta (BIPV) with thousands of small residential/rural off-grid systems. In 2008, the Alberta Government introduced a micro-generation regulation allowing PV systems up to one MW to sell excess

electricity into the grid. Residential PV systems are usually less than 10 kW.

Examples include:

- Two Alberta PV-based sustainable housing projects under the Canada Mortgage and Housing Corporation's (CMHC's) EQuilibrium™ Sustainable Housing Demonstration Initiative.
- The Avalon Discovery Equilibrium house in Red Deer, using PV integrated roofing tiles generates more energy than it consumes, supplying the excess to the Alberta grid.
- The Alberta Solar Municipal showcase demonstration project involving PV systems on buildings in 20 municipalities.

Centralized PV power plants as found in Europe and the USA do not yet exist in Canada. Ontario's Green Energy Act has definitely stimulated interest in large-scale PV power plants. However, their development in other provinces will depend on whether or not some market support measures are introduced.

HOW DOES PV CONTRIBUTE TO ECONOMIC DEVELOPMENT?

Opportunities for Alberta communities exist in both the application of PV applications and in manufacturing and services related to this rapidly growing industry. About 40% of the costs of a system are for local installation, mounting, design and regulatory compliance.

In its 2008 report to the International Energy Agency (IEA), Natural Resources Canada's (NRCan) Canmet Energy estimated the Canadian PV market to be worth CAD 500 million. This represents over 300 solar energy companies (sales companies, wholesalers, product manufacturers, project developers, private consultants, systems installers and industry associations) in Canada.

The leading silicon producer is Timminco Limited, based in Quebec. Several Canadian leaders in cell and module production are based in British Columbia. It is important to note that nearly 75% of Canada's PV sales are for the export market.

The world leader in PV system production is China, followed by Europe, Japan and Taiwan. Major companies include, Q-Cells (Germany), Suntech (China), First Solar (USA/Germany/ Malaysia) and Sharp (Japan). Other market leaders in terms of supply and installation include Renewable Energy Corporation (REC) from Norway, BP Solar, Gintech, Mitsubishi and Deutsche Solar AG

Canmet estimates that about 2090 people are employed in the industry in Canada.

WHAT RESOURCES ARE NEEDED?

The only resource needed for the application of PV systems is sunlight. Even though some areas of Alberta receive more sunlight than others, PV systems can be applied almost everywhere either on or integrated into buildings that have exposure to the sun.

HOW DO PROJECTS GET STARTED?

The Alberta Solar Showcase, involving 20 municipal organizations across the province, is a good example of how projects get started. New grid-connected solar PV systems were installed on highly-visible municipal buildings around Alberta.

It has helped inform and educate municipal leaders, administrative staff, facility maintenance personnel, electrical inspectors and utility providers, and assisted in building capacity and experience within the local solar industry.

WHAT ABOUT THE ENVIRONMENT?

During their electricity generation lifetime of more than 25 years, PV modules have no adverse impact on the environment.

While the purification process in silicon PV cell manufacturing is energy-demanding, advances in technology are making continuous improvements in energy reduction.

WHERE TO GET MORE INFORMATION

1. Solar and Sustainable Energy Society of Canada www.sesci.ca and Northern Alberta Chapter http://solaralberta.ca
2. Alberta Solar Municipal Showcase www.lassothesun.ca
3. Climate Change Central www.climatechangecentral.com
4. PV Potential and Insolation Map of Canada http://glfc.cfsnet.nfis.org
5. Canadian Solar Industries Association www.cansia.ca
6. Canadian Solar Building Research Network www.solarbuildings.ca
7. Ontario Sustainable Energy Association www.ontario-sea.org
8. International Solar Energy Society www.ises.org
9. Solar Energy International www.solarenergy.org
10. European Photovoltaic Industry Association www.epia.org
11. United States Solar Electric Power Association www.solarelectricpower.org

What about Geothermal electricity?

While wind, solar and bioenergy are renewable sources of energy from above the ground, geothermal energy taps into the energy beneath the ground. This is why it is sometimes called "heat mining".

In the 6,000 kilometers from the surface of the earth to its centre, the temperature of the molten rock can reach 5,500 degrees Celsius. The USA Geothermal Energy Association states that, "the heat continuously flowing from the Earth's interior is estimated to be equivalent to 42 million MW of power and is expected to remain so for billions of years to come, ensuring an inexhaustible supply of energy."

Geothermally-generated electricity is distinct from ground-source heat pumps (GSHP). Heat pumps use either the earth or groundwater, mainly for space heating and cooling, not generating electricity.

HOW DOES IT WORK?

Traditional geothermal energy taps into reservoirs of hot water or steam in the ground, drawing it to the surface through a wellhead. The hot water or steam then drives a turbine to produce electricity. Wastewater, after passing through a condenser is reinjected back into the ground through a second wellhead, prolonging the useful life of the system. This is commonly referred to as an "open loop" system.

Enhanced Geothermal Systems (EGS) drill wells much deeper into the ground. Instead of tapping into existing reservoirs of hot water or steam, they inject water from the surface through a wellhead and use the heat from the ground to produce hot water or steam. As in traditional geothermal, the wastewater is reused in a continuing cycle. This is commonly referred to as a "closed loop" system

HOW IS IT USED?

Centralized electricity power plants are located directly at the wellhead sites. As with other sources of centralized electricity generation, connection to the electricity grid is a requirement.

In contrast to wind and PV generated electricity, geothermal electricity contributes to the base load needs as it can provide a constant energy source as opposed to an intermittent one.

WHAT IS THE TECHNOLOGY USED?

Traditional geothermal reservoirs are located closer to the earth's surface where the rock is porous (less than 3 km). While such reservoirs occur in British Columbia and the Yukon, they only occur in Alberta within the boundaries of Jasper National Park and Banff National Park (not available for development).

The best conditions for tapping into EGS are where a temperature of 150 degrees Celsius can be obtained at less than 7 km underground. Alberta Innovates – Energy and Environmental Solutions (AIEES) has undertaken an initial mapping of potential EGS sites in Alberta (study by Jacek Majorowicz and Michal C. Moore commissioned by the former Alberta Energy Research Institute). Best sites are at a depth of less than 7 km and are located primarily in northwestern Alberta and in central-eastern Alberta (based on available mapping).

WHAT RESOURCES ARE NEEDED?

The technology and drilling techniques for EGS are similar to existing drilling practices in the oil and gas industry.

HOW CAN GEOTHERMAL ELECTRICITY CONTRIBUTE TO ECONOMIC DEVELOPMENT?

EGS is still in the research and development stage with demonstration projects located in a number of countries. It is not yet cost-effective.

For Alberta, potential opportunities cited include:

- Unconventional" EGS which co-produces hot water from oil and gas production.
- Use of carbon dioxide (in carbon sequestration) to fracture the rock to enable water to be pumped in.
- Utilization of end-of-life oil and gas wells for EGS.
- Utilization of end-of-life coal mines (e.g. Crowsnest Pass Region)
- Production of power for oil sands projects, replacing natural gas.

The Canadian Geothermal Energy Association (CanGEA) has set a target of 5,000 MW of geothermal electricity by 2015 in Alberta, British Columbia and the Yukon.

The US Geothermal Energy Association cites the following economic development parameters for each 1,000 MW of geothermal energy produced:

- $4 billion capital investment
- 6,000 person-years of manufacturing and construction employment
- 1,800 permanent jobs

Skills for geothermal energy are transferable from the oil and gas industries

Resources needed for EGS are:

- A good location with adequate temperatures at a reasonable depth.
- The ability to connect to the grid to supply base-load power.
- The availability of sufficient water to pump into the well.

Additional mapping is required to determine specific sites.

HOW DO PROJECTS GET STARTED?

All projects are at the research and development or demonstration phases. They involve serious private sector companies, usually with government financial assistance for development projects.

In Alberta, the most likely private sector initiators will come from the oil and gas industries in cooperation with companies that have geothermal expertise.

WHAT ABOUT THE ENVIRONMENT?

A landmark study on EGS was undertaken by an Massachusetts Institute of Technology (MIT) panel and released in January 2007. The study evaluated the environmental impact as follows:

"The panel also evaluated the environmental impacts of geothermal development, concluding that these are "markedly lower than conventional fossil-fuel and nuclear power plants."

"This environmental advantage is due to low emissions and the small overall footprint of the entire geothermal system, which results because energy capture and extraction is contained entirely underground, and the

surface equipment needed for conversion to electricity is relatively compact,"

The report also notes that meeting water requirements for geothermal plants may be an issue, particularly in arid regions. Further, the potential for seismic risk needs to be carefully monitored and managed."

WERE TO GET MORE INFORMATION

1. Alberta Innovates - Energy and Environment Solutions (www.albertainnovates.ca) – to access study, "Enhanced Geothermal Systems in the Alberta Basin", Jacek Majorowicz and Michal C. Moore.
2. Canadian Geothermal Energy Association (www.canGEA.ca)
3. USA Geothermal Energy Association (www.geo-energy.org)
4. www.geothermal.inel.gov/publications/future_of_geothermal_energy.pdf) to access MIT study of January 2007.
5. International Geothermal Energy Association (www.geothermal-energy.org)

What about electricity from Biomass?

Biomass can be used to produce energy in the forms of electricity, heat and fuels. This profile deals with electricity generation and combined heat and power (CHP). Other profiles consider heat from biomass, biofuels for transportation and biorefineries that have the potential to produce multiple products.

WHAT IS BIOMASS?

Biomass is a biological material that comes from forests, agriculture and organic community waste. Alberta has both forest and agricultural biomass – particularly hay, straw and forest residues.

Biomass used for energy is often a "residue" from other operations such as forest harvesting, wood product manufacturing and agriculture. But it can also be an "energy crop" – a forest or agriculture crop harvested for the sole purpose of energy development.

Biomass sources can differ substantially in how they can be used for bioenergy. The main factors are:

- Moisture content
- Ash content
- Energy value
- Size and texture
- Levels of contamination with other materials

Biomass usually originates as a solid form. It can be turned into other solids (wood pellets from wood chips), liquids (oils from crops) or gases (methane from landfills).

WHAT TECHNOLOGIES ARE USED?

The main technologies to transform biomass into energy are thermal conversion technologies (combustion, gasification and pyrolysis), anaerobic digestion and fermentation.

Most power plants use the source of heat to produce electricity only and do not fully use the excess heat that is co-produced with the electricity. Systems that make full use of both electricity and heat production are called Combined Heat and Power plants or Co-generation plants. When the heat is fully used efficiency can be as high as 85%.

In Europe the trend is to convert power plants (or to construct new ones) as Combined Heat and Power Plants (CHP).

Alberta has the largest CHP electricity plant in Canada – the Joffre Cogeneration Combined Cycle Gas Turbine facility. The plant generates all the electricity and process heat needed to operate a nearby petrochemical plant with substantial surplus electricity sold into the electricity grid. While the technology to integrate biomass into gas turbine plants is not yet commercial, the presence of strong leaders in CHP technology in the province could be a major benefit in future applications that can include biomass CHP.

For electricity generation from biomass the current main technology is the combustion of wood chips or pellets as well as hay/straw. Gasification (syngas) of forest and agricultural biomass is emerging.

HOW IS BIOMASS USED NOW IN ELECTRICITY GENERATION?

Basically three configurations exist to transform biomass into electricity:

1. **Industrial applications** that produce electricity from biomass (and usually also heat) for their own purposes, selling the excess to the grid.

   In Canada, the pulp and paper industry has been at the forefront in the generation of electricity and process heat from biomass (hog fuel) and "black liquor" a by-product of the pulping process. The industry is responsible for the majority of the biomass electricity generating capacity in Canada. Leading provinces are BC, Ontario, Quebec, Alberta and New Brunswick.

   Forest product-based combined heat and power (CHP) facilities are located in Drayton Valley, Whitecourt and Grande Prairie.

2. **Power plants** that can run entirely on biomass or fossil-fuel plants that are co-fired with biomass.

   In the USA, about 40 dedicated biomass power plants using forest and agriculture residues, mainly in California, Maine and Michigan supply electricity to the grid. In Europe, coal plants co-fire with wood pellets (using over 80% of Canadian wood pellet production). In Alberta, a biomass gasification facility exists in Dapp.

3. **Waste-to-energy incinerators** installed in communities, mainly in Europe and Asia, which take biomass and produce heat and electricity.

   In Germany, advanced combustion technology systems take all forms of municipal waste, even toxic waste imported from other countries.

HOW ELSE COULD BIOMASS BE USED FOR ELECTRICITY?

Small amounts of electricity can be produced by the extraction of methane from landfill sites and many municipalities are developing that option with connections to the grid. There is significant potential to use a complimentary generation system within coal fired plants.

Electricity generated at power plants relies on some form of heat source to drive a steam turbine or a gas turbine (or a combination of both in a "combined cycle". In Alberta, 90% of the electricity is produced from coal and natural gas.

Biomass that is combusted can act as a supplementary or alternate source of heat for the production of electricity.

HOW CAN BIOMASS ELECTRICITY CONTRIBUTE TO ECONOMIC DEVELOPMENT?

In the event of the development of biomass co-firing in coal-fired electricity plants, the main opportunity for rural communities would be in the supply of biomass to the power plants. If a 400 MW coal plant is co-fired at 5%, the biomass requirement would be about 125,000 bone-dry-tonnes (BDT) per year (about double the amount when wet)[1].

If the power plant is using wood chips, this involves the harvesting, chipping and transportation of the chips to the power plant, usually in a wet state. Dedicated biomass power plants in United States generally use chips, other wood residues and sometimes agricultural feedstocks like hay and straw.

But usually, for convenience of handling, biomass co-fired power plants use or plan to use wood pellets. The economic development opportunity then is the establishment of a pellet mill to produce the pellets.

As a basic rule of thumb, biomass is most cost-effective in chip or other wood residue form if it does not have to be transported more than 100 km. Wood pellets can support much higher transport distances (e.g. export to Europe from Canada) as their sales price is three to five times higher than wood residues. While wood pellets dominate the market, pellets from agriculture, which have higher ash content, are under development.

The production of biomass for electricity generation is of primary benefit to entrepreneurs and existing lumber mills in the wood products industry. At present, Alberta has a limited capability in pellet production. In a pellet plant operation, skills from the wood harvesting and yard handling processes are directly transferable. However, new skills related to the operation of the pellet mill would be required.

British Columbia is recognized as the province with the greatest expertise in pellet production, sales and transportation.

WHAT RESOURCES ARE NEEDED?

For the supply of biomass for the production of electricity or for heating, the greatest need is access to wood fibre resources. When the wood products sector is strong, lumber mills have a surplus of residues that can be used for biomass combustion and/or pellet production. However, when fewer mills are operating and the demand for pulp and paper is low, wood residues and wood chips for the production of pellets are in short supply (low production).

1 Based on estimates contained in, *Feasibility Study: Identifying Economic Opportunities for Bugwood and Other Biomass Resources in Alberta and BC*, prepared by Levelton Consultants Ltd. for the Alberta Energy Research Institute

This means that any new biomass operation needs access to direct forest resources and needs such access on a long-term basis to justify new investment and to secure sales contracts. In Alberta, as in many other provinces, access to forest resources for new industry participants is often a limiting factor. In several Canadian provinces, forest tenure reform is actively being considered to allow greater access for bioenergy feedstocks.

Nevertheless, local solutions working with existing forest industry players (licence holders and logging contractors) should be explored.

HOW DO PROJECTS GET STARTED?

The development of biomass co-firing of coal electricity plants in Alberta will depend on four factors:

1. The pressures across Canada and from United States for a reduction in coal-fired generation and the negative emissions impact on the environment.
2. The incentive measures that might be put in place by the Government of Alberta to encourage co-firing.
3. The availability of biomass primarily in the form of wood residues and/or wood pellets.
4. And, most importantly, the decisions by the private sector coal power plants to incorporate biomass co-firing.

   Communities that are within 100 km of coal plants in Alberta can take some pro-active steps to determine the likely availability of and capacity to supply biomass within the plant catchment area.

WHAT ABOUT THE ENVIRONMENT?

Co-firing with biomass is not an alternative but a complementary action to further reduce emissions of sulphur dioxide (SO2), nitrogen oxide (NOX) and carbon dioxide (CO2) from electricity generation processes. The use of biomass can make a significant contribution to the reduction of these emissions. For instance, the carbon dioxide that biomass gives off when it is burned is counterbalanced by the amount absorbed when the plant/species in question was ground and replaced after harvesting.

Nevertheless, combustion of biomass does create some concerns for emissions – particularly nitrogen oxide (NOX) and particulates so the integration of biomass combustion with coal must be carefully planned.

WHERE TO GET MORE INFORMATION

1. Alberta Forest Products Association www.albertaforestproducts.ca
2. Forest Products Association of Canada www.fpac.ca
3. Alberta Innovates – Energy and Environment Solutions www.albertainnovates.ca – to access the footnoted "Bugwoood Study"
4. USA Biomass Power Association www.usabiomass.org

5. International Energy Agency (IEA)
   www.iea.org – See Biomass for Power Generation and CHP
6. Capital Power
   www.capitalpower.com – joint owners of Genesse 3 with TransAlta
7. PowerScorecard
   www.powerscorecard.org

What about heating and cooling with renewable energy?

The world's biggest use of energy is for heating and cooling purposes (about 50%). Electricity uses 20% and transportation 30%. In Canada, furthermore, 70% of energy used in residential and commercial institutions is used for heating.

Renewable energy can be used to generate electricity which can, in turn, provide heating, cooling and lighting.

But solar thermal, geothermal and bioenergy can be used directly to produce space heating, hot water and cooling for individual homes, commercial or institutional buildings, for groups of buildings and for entire communities. This is referred to as "low heat" that is under 180 degrees Celsius.

The focus of renewable heating and cooling is the building. Some jurisdictions – in particular Europe – intend to phase out fossil fuel energy sources for new buildings and are already making a certain percentage of energy from renewables mandatory.

At the same time, many are working on making buildings more efficient users of energy and are developing ways to "integrate" renewable energy production into the structure and cladding of buildings. Some predict that by 2030, the "Building" will be the most common energy system.

HOW IS IT USED?

Bioenergy requires the combustion of biomass to produce hot water which can then be used directly for heating in radiators and hot water tanks.

Solar thermal energy and geothermal energy do not require combustion. They "collect" heat from the sun or from the earth and use it to heat hot water.

All three technologies can use heat exchangers to transform heat from hot water to hot air, which can then be used similarly to forced air furnaces. Also all can use condensers to transform heating to cooling.

The three most common ways in which renewable heating and cooling is used are:

1. In individual homes or larger multi-family buildings.

   The use of solar thermal to produce hot water is probably the widest use, followed by geothermal for heating and hot water, and solar for heating. Bioenergy boilers using pellets, chips or logs are slowly being introduced to the market.

2. In commercial and institutional buildings.

   In Canada, the use of geothermal for this sector is more widespread than for individual homes. Solar thermal is developing. In Europe and United States the use of bioenergy is much more common in this sector than in Canada.

3. In District Heating and Cooling systems that can service a group of buildings and even entire communities.

   All three forms of renewable energy can work in a District Heating system.

   The Drake Landing Solar Community in Okotoks, Alberta is a good example of a solar thermal district energy system providing space heating for about 50 homes. The system also uses a borehole to store heat in the summer for use in the winter.

A fourth market sector is applications to industrial processes. At present, only bioenergy is applicable but research is ongoing for solar thermal and geothermal.

Strathcona County also has a District Energy system fired by fossil fuels but envisages using renewable fuels, such as biomass, in the future.

WHAT IS THE TECHNOLOGY USED?

Solar thermal

- Solar collectors (dominated by flat plates on roofs) filled with water or glycol carry water to a heat exchanger that then heats water.
- Canada leads the world in solar air collector technology that does not use a liquid. The main application, so far, is for air heating in commercial buildings. This technology includes "solar walls".

Geothermal

- A continuous loop of pipes 10 to 30 feet underground or in water extract heat from the ground. A "heat pump" concentrates the heat and transfers it to water or air for space heating. Heat can also be returned to the earth for storage as a way of air conditioning homes and buildings.

Bioenergy

- Bioenergy boilers produce hot water for heating by combusting biomass (usually pellets at the residential level). A heat exchanger can transform the hot water into hot air, as in a traditional forced air furnace.
- Larger bioenergy boilers that can combust a greater variety of biomass can produce hot water in district heating systems and in industrial applications. Often such systems are configured to produce both heat and electricity (Combined heat and power) with the power usually sold to the electricity grid.

All three of the technologies can be used in combinations. For instance, many new houses in Germany combine a biomass pellet boiler with a solar water heater. Increasingly, in Europe biomass district heating systems are adding solar thermal arrays. The use of solar thermal panels (heat) and solar PV panels (electricity) on the same building is another possibility.

Common areas of further technology development relate to energy storage, advancement in cooling, building integration and district systems.

HOW DOES HEATING AND COOLING CONTRIBUTE TO ECONOMIC DEVELOPMENT?

In contrast to the large projects for the generation of electricity, heating and cooling from renewable energy used in building applications relies upon a host of small and medium sized companies for installation, maintenance and sales – heating equipment sales companies, heating and cooling contractors, pellet distributors etc.

Training specific to renewable energy heating and cooling is required for all of these positions. Engineering education at the engineering professional level is offered by the University of Alberta and specific training related to the sales, installation and trades positions is offered by several Community Colleges.

In Europe about 30,000 to 40,000 people are employed in the solar thermal industry which has annual sales of $4.5 billion (Can). As Europe has been the leader in solar thermal and bioenergy technology development, most of the larger manufacturers are based there. However, Canadian manufacturing capability is developing.

WHAT RESOURCES ARE NEEDED?

In the case of solar thermal and geothermal, no natural resources are required other than exposure to sunlight or access to the heat of the earth. As such, solar and geothermal heating and cooling systems can be installed almost anywhere. As nearly all of these systems have electronic controls, some electricity is required.

For bioenergy systems, access to biomass is required. For residential and most small commercial systems this usually means access to wood pellets. As pellets can absorb higher transport costs than wood chips, their availability is increasing – even in areas where pellets are not produced. To heat a typical house, about five tonnes of pellets would be required annually. Availability of wood chips will depend on geographic location and on the ability of a community or investor to secure a long-term local supply.

For district heating and cooling systems, insulated pipes must be laid in the ground for

both the collection and distribution systems (water). The depth is not below three feet, but their installation can create some temporary disruption to pedestrian and automobile traffic.

HOW DOES A PROJECT GET STARTED?

The installation of renewable hot water and heating systems in individual residences can be undertaken directly by the owners in a retrofit but are more usually installed in new buildings at the time of construction.

The same is true of commercial and institutional buildings such as schools, hospitals or municipal buildings.

District energy systems are a more complex undertaking and are either lead by a municipality or by a project developer. For instance, the Drake Landing Solar Community involved a developer, a builder, a utility operator, an engineering company and equipment suppliers. The municipality was involved in the standards and approvals process.

In Europe, it is not uncommon for district energy projects to be initiated by a municipality but then operated by either a cooperative or by a private company.

The District Energy system in Calgary, while using natural gas, has an investment requirement of about $30 million.

WHAT ABOUT THE ENVIRONMENT?

As a general rule of thumb, each home that uses electricity and/or some form of fossil fuel produces about six to seven tonnes of Greenhouse Gas Emissions (GHG's) every year. So any application of renewable energy for heating and hot water will provide a reduction in emissions – the actual amount depending on the system used and on the percentage of energy use replaced. When the Drake Landing Solar Community is at full operation (90% energy replacement) each home will save over five tonnes in GHG emissions.

Very few environmental issues arise in connection with the use of renewable energy for heating, hot water and cooling. However, the most efficient bioenergy boilers for residential and commercial/institutional application that come from Europe must be certified for use in North America. Even though European technology usually exceeds North American standards, the certification process can be long and expensive.

WHERE TO GET MORE INFORMATION

1. Solar and Sustainable Energy Society of Canada www.sesci.ca and Northern Alberta Chapter http://solaralberta.ca
2. Climate Change Central www.climatechangecentral.ca
3. Alberta Geothermal Energy Association (www.agea.ca)
4. Drake Landing Solar Community www.disc.ca
5. Canadian GeoExchange Coalition www.geo-exchange.ca
6. Canadian Bioenergy Association (Canbio) www.canbio.ca
7. Canadian Solar Industries Association www.cansia.ca
8. Canadian Solar Building Research Network www.solarbuildings.ca

9. Natural Resources Canada – Canmet Energy
   http://canmetenergy-canmetenergie.nrcan – rncan.gc.ca
10. Ontario Sustainable Energy Association www.ontario-sea.org
11. International Solar Energy Society
    www.ises.org
12. Solar Energy International
    www.solarenergy.org
13. European Solar Thermal Industry Federation www.esttp.org

What about Biofuels?

WHAT IS BIOMASS?

Biofuels are produced from biomass. Biomass is a biological material that comes from forests, agriculture and community organic waste. Alberta has both forest and agricultural biomass – particularly hay, straw, wheat, and canola and forest residues.

Biomass used for energy is often a "residue" from other operations such as forest harvesting, wood product manufacturing and agriculture. But it can also be an "energy crop" – a forest or agriculture crop harvested for the sole purpose of energy development.

Biomass sources, referred to as feedstocks, can differ substantially in how they can be used for bioenergy. The main factors are:

- Moisture content
- Ash content
- Energy value
- Size and texture
- Levels of contamination with other materials

Biomass usually originates as a solid form. It can be turned into other solids (wood pellets from wood chips), liquids (oils from crops) or gases (methane from landfills).

WHAT ARE BIOFUELS?

Transportation is the single largest source of Greenhouse Gas Emissions (GHG's) and demand for fuel is expected to grow more rapidly than any other sector up to 2020. Thus replacing or blending fossil fuels with biofuels is a priority in most countries.

The main biofuels are biodiesel and ethanol. The biomass used for both is predominantly

agricultural (canola, sunflower, tallow for biodiesel; corn, wheat, and sugarbeets for ethanol). The main Alberta biofuel sources are wheat and canola. Biogas is also considered as a biofuel here, although it can be used for the production of heat and electricity.

WHAT TECHNOLOGIES ARE USED TO PRODUCE BIOFUELS?

Biodiesel

Biodiesel is made primarily from vegetable oils by reacting the oil with an alcohol (usually methanol) in the presence of a catalyst. The resulting chemical reaction (called transesterification) produces biodiesel and glycerine as a byproduct. Biodiesel represents under 2% of the global diesel market. Biodiesel can be blended up to 25% with hydrocarbon fuels for use in today's vehicles.

Ethanol

Ethanol is water-free alcohol produced by the fermentation of sugar or starch contained in grains - primarily wheat in Alberta - and corn in Eastern Canada. About four million bushels of wheat are needed to produce 40 million litres of ethanol.

Ethanol is also blended with gasoline, but currently only up to a maximum of 10% (E-10). Some specifically designed commercial vehicles can use a blend up to 85% ethanol (E-85). Ethanol represents less than 4% of global gasoline consumption.

Second-generation biofuels

Second-generation biofuels are those that can be produced from ligno-cellulosic materials which includes both forest and agriculture feedstocks. While plant demonstrations of the technologies involved are underway, the market is not expected to be fully commercial before 2015. Second generation biofuels will usually involve the co-generation of electricity.

Ligno-cellulosic biofuels come from a wider variety of non-food feedstocks, provide greater environmental benefits and will eventually be cheaper to produce than current processes. Examples of feedstocks are switchgrass, miscanthus and wood chips. Second generation agriculture feedstocks for biodiesel would use algae.

Canada is a leader in second generation ethanol technology. Third generation biofuels are algae-based and are likely to become commercial only after 2015.

Other biofuels

Biogas is mainly methane produced by anaerobic digestion using manure, sewage, organic municipal waste and energy crops. It can be compressed like natural gas and used to power vehicles. More usually, it is used as a fuel for a combustion process.

Pyrolysis oil (also referred to as bio-oil) is currently produced from wood residues and is slowly entering the biofuel market. It can be blended with hydrocarbon fuels or upgraded to make green gasoline or diesel. Two Canadian companies who are leaders in this technology are Dynamotive and Ensyn.

Syngas produced from biomass is an emerging technology.

Biorefineries

The concept of a biorefinery is to achieve economies of scale in combining several technological processes to produce multiple green energy and related products. The pathway to biorefineries is predominantly through the production of biofuels but also

through the process of producing pulp in the pulp and paper industry.

For instance, the Growing Power Hairy Hill project in Alberta will produce ethanol from wheat. The byproduct of distillers grain will be used as a cattle feed. The manure from the cattle will go through an anaerobic digester to produce biogas which, in turn, will produce hot water and electricity needed to power ethanol production, with excess electricity being sold into the Alberta grid. The anaerobic digestion will also produce organic fertilizers as a commercial byproduct. The Permolex plant in Red Deer is already in operation.

The concept of a full biorefinery is to replicate an oil refinery that is capable of producing a wide range of chemical and related products just as oil does today. While progress is substantial, the concept is unlikely to be fully realized in the near future.

HOW CAN BIOFUELS CONTRIBUTE TO ECONOMIC DEVELOPMENT?

The main beneficiary of biofuels is the agricultural sector as forest biomass can only be used once second generation biofuel technology comes to market.

The Alberta agricultural sector is already prominent in the production of crops that are used in biofuels and has also developed downstream activities in processing, such as oilseed crushing. The production of biofuels is a natural extension of these activities.

Alberta has a number of biodiesel and ethanol production plants in operation and many more are in the planning and feasibility stages.

Biodiesel plants have been established in Aldersyde and Lethbridge with a number of other plants proposed. An ethanol plant is located in Red Deer with others being proposed for Alberta. As well, ethanol gasification projects are planned for Drayton Valley and the City of Edmonton.

About five biogas operations exist, with others planned.

WHAT RESOURCES ARE NEEDED?

The main resources needed are the crops required to produce the biofuels as well as animal residues (for biodiesel). The requirements for large-scale biogas are proximity to a dairy or hog operation or food processing plant. The blending of feedstocks is also possible.

A major issue in biofuel production is the need for substantial amounts of water in the current processes used. While water recycling (non-consumptive) is growing, consumptive water use is in the range of two to six gallons of water needed for each gallon of biofuel produced. Water use for biofuels is higher than water used in fossil-fuel gasoline refining. Water use is also an environmental concern in areas where water consumption is already high compared to availability[2].

HOW DO PROJECTS GET STARTED?

Projects get started usually by those entrepreneurs and investors who are already present in the agricultural sector or in biofuels development elsewhere. Many projects are in the hundreds of millions of dollars, although some smaller scale projects are possible. Alberta biofuel project listings and locations can be found on the government website (www.agric.gov.ab.ca).

2 Water Implications of Biofuels Production in the United States, National Research Council, 2008 – ISBN 0-309-11362-8

WHAT ABOUT THE ENVIRONMENT?

The production and use of biofuels has a definite environmental benefit in reducing the amount of fossil fuel based products used in transportation. Biofuels can make a significant reduction to GHG emissions and several of the feedstocks of Alberta show an increased benefit compared with other biofuel feedstocks.

The recent concern with the production of biofuels is the claim that they have led to food price increases and shortages resulting from the competition of biofuels for food crops. The Alberta Biodiesel Association website provides a full briefing that deals with this issue.

Nearly all biodiesel projects existing or proposed in Alberta are based on manure and food processing wastes which can lead to odour control challenges.

With respect to ethanol production, the energy balance of producing ethanol from corn has been questioned, as the energy input required can be equal to or greater than the energy provided by the resulting ethanol. Quebec has banned any new ethanol from corn.

This is not an issue for Alberta as the production of ethanol from wheat feedstock has a much better energy balance. The situation is similar for biodiesel production in Alberta.

A limiting factor when considering many biofuel projects, is the availability of a reliable source of water for various production processes.

As second generation biofuels develop and other uses of biomass for energy advance, the use of dedicated forest and agricultural crops will also grow (as opposed to just residues from other activities). In this case the balance of land used for biofuels and food production will likely be an increasingly important issue for the public.

WERE TO GET MORE INFORMATION

1. Alberta Biodiesel Association www.albertabiodiesel.org
2. Alberta Ethanol Association (information) www.agric.gov.ab.ca for Alberta biofuel project listings
3. Alberta Research Council www.biofuels.arc.ab.ca – for biodiesel testing
4. The Canadian Renewable Fuels Association www.greenfuels.org
5. Canola Council of Canada www.canola-council.org
6. United States Dept. of Energy Renewable Fuels Data Centre www.afdc.doe.gov
7. International Energy Agency (IEA) www.iea.org

Renewable energy community strengths weaknesses analysis?

This Checklist provides a framework to conduct a preliminary Strengths and Weaknesses Analysis to help determine the type of renewable energy project(s) that might provide the best fit for the community. It assumes that your community has already gone through a similar exercise for general community and economic development purposes. Place an "S" (strength) or "W" (weakness) in the appropriate boxes. Shaded areas in boxes indicates that the question is not relevant (or only of limited relevance) to that particular renewable energy sector.

When you have completed the exercise consider the balance of strengths and weaknesses by renewable energy sector and look more closely at the range of project types within the sector (from the list of project types). Some issues or questions would be more critical than others requiring a relative rating, but this preliminary exercise does not take that into account.

The questions for you to think about are intended to provide assistance only and are not necessarily all of the issues that could be considered.

	QUESTIONS FOR CONSIDERATION	WIND	SOLAR PV	GEO THERMAL	BIOENERGY ELEC & CHP	HEATING & COOLING	BIOFUELS
INTERNAL TO THE COMMUNITY							
1	Does the Canada Wind Atlas www.windatlas.ca indicate that your area has strong wind speed?						
2	Even if the Atlas does not show strong overall wind speed in your area, do you know whether you have specific sites (ridges, ravines etc) that could be suitable?						
3	Off-grid residential and commercial application						
4	Does the Canada Photovoltaic (PV) Potential Map of Canada (http://glfc.cfsnet.nfis.org) show PV potential for your area?						

	QUESTIONS FOR CONSIDERATION	WIND	SOLAR PV	GEO THERMAL	BIOENERGY ELEC & CHP	HEATING & COOLING	BIOFUELS
INTERNAL TO THE COMMUNITY (cont'd)							
5	Are you in an area where agricultural resources could be available as bioenergy feedstocks?						
6	Do you have a pulp and paper mill or lumber mill located in your area? *(potential for conversion or expansion)*						
7	Do you already have a central electricity generating plant in your community or area? *(potential to use renewable sources of energy or to use excess heat)*						
8	Are you in an area of known geothermal "hot spots" *(where sufficient heat is closer to the surface)* and/or an area of end-of-life oil wells or coal mines?						
9	Is access to the electricity grid possible for potential projects?						
10	If not, are there plans to upgrade the grid that would make access possible?						
11	Do you have larger single buildings or a cluster of buildings for which renewable energy could be an opportunity?						

	QUESTIONS FOR CONSIDERATION	WIND	SOLAR PV	GEO THERMAL	BIOENERGY ELEC & CHP	HEATING & COOLING	BIOFUELS
INTERNAL TO THE COMMUNITY (con'd)							
12	Do you have any builders or property developers in your area who have shown interest in sustainable housing? *(potential for renewable energy sub-divisions)*						
13	Does your community have sufficient water resources? (can be constraint for some projects)						
14	In which sectors of renewable energy do you have local knowledgeable people or educational organizations?						
15	Do you have companies with relevant renewable energy skills, goods or services?						
16	In which sectors do you already have renewable energy projects?						
17	Which renewable energy sectors would be acceptable to residents of your community?						
18	Other considerations?						

	QUESTIONS FOR CONSIDERATION	WIND	SOLAR PV	GEO THERMAL	BIOENERGY ELEC & CHP	HEATING & COOLING	BIOFUELS
INFLUENCES FROM OUTSIDE THE COMMUNITY							
19	In which sectors have you had any initial enquiries from renewable energy developers from outside the area?						
20	In which sectors have other communities in your region had any initial Inquiries from renewable energy developers from outside the area?						
21	In which sectors have other communities in your region considered renewable energy development?						
22	In which sectors have other communities in your region successfully established renewable energy projects?						
23	In which sectors would some form of government incentive be available to renewable energy project developers?						
24	Other Issues?						

COMMUNITY RECEPTIVENESS

This Checklist is meant to help communities ensure that residents, community leaders and local organizations understand the potential opportunities and risks of renewable energy and are receptive to its development. The groups for consideration are: the general public and civic groups; the business community; municipal government leaders; and, educational institutions.

The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
GENERAL PUBLIC AND CIVIC GROUPS			
Understanding			
1	Has an information and discussion session on renewable energy been organized for the general public? This could include renewable energy generation, renewable energy contribution to energy conservation and how renewable energy projects can further economic development.		
2	Has your community produced or made available a general renewable energy information pamphlet for the general public?		
3	Have local service organizations included renewable energy on their topic list for speakers?		
4	Have information sessions on particular types of renewable energy been organized i.e. wind, solar, bioenergy, geothermal?		
5	Has the local media shown an interest in reporting on renewable energy?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
GENERAL PUBLIC AND CIVIC GROUP (cont'd)			
Opportunity			
6	Does the public understand the potential economic development opportunity of renewable energy projects and the potential risks?		
7	Have you considered doing an economic impact study of the potential benefits relating to investment and job creation/retention?		
Issues raised			
8	Has any member of the public raised concerns with respect to perceived negative aspects of renewable energy? This might include, for instance, • Noise and/or visual impact of wind turbines • Forest harvesting practices of biomass • Use of food crops for biomass • Odours from processing biomass		
9	Has any member of the public raised concerns with respect to any social issues that might be created by new renewable energy projects? These might include, for instance, • Impact on housing or schools • Impact on transportation and roads		
10	Have you been able to respond to concerns and to lessen?		
11	Do you know how to access additional knowledge for the concerns or direct the concerns to an expert in Alberta?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
GENERAL PUBLIC AND CIVIC GROUP (cont'd)			
Process			
12	Do you have a public consultation process for the public to provide input on any renewable energy projects that might come along?		
13	Is the public aware of what the process is?		
ESTABLISHED COMMUNITY BUSINESSES			
Understanding			
14	Has the community or local business organizations organized renewable energy information sessions for the existing business community?		
15	Has the community or local business organizations produced or made available renewable energy information pamphlets for the business community *(overall renewable energy or specific sources of renewable energy).*		
Opportunity			
16	Does the business community understand the potential opportunities in either initiating renewable energy projects or acting as suppliers of goods and services to projects that could move forward? The relevant sectors could include: • Local component manufacturers or distributors • Engineering, surveying, management consulting, legal or other specialized service providers • Construction companies • Forest and agriculture entities • Transportation companies		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
ESTABLISHED COMMUNITY BUSINESSES (cont'd)			
Issues Raised			
17	Has the business community raised any issues relating to renewable energy development? These might include, for instance, • Process for the approval of new projects • Access to renewable energy forest and agriculture feedstocks • Process to develop a local or regional "bioenergy cluster"		
18	Has a mechanism been put in place for the business community to explore these issues?		
MUNICIPAL GOVERNMENT LEADERS			
Understanding			
19	Have municipal leaders had an opportunity to hear a presentation on renewable energy opportunities?		
20	Do they have an understanding of what the potential impact of renewable energy projects might be on the need to plan and upgrade community services?		
21	Have community leaders had the opportunity to attend conferences or shows relating to renewable energy?		
22	Have community leaders considered joining a study tour to see how renewable energy has developed in other communities around the world?		
23	Have they considered the need to review by-laws that might have some impact on developing renewable energy? This could include, for instance, • Burning regulations associated with bioenergy boilers • Placement of solar electricity or heat collectors on buildings • If trenching for a district heating system, desirability of putting all cable, telephone and hydro lines in the same trench as the hot water heating pipes		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
EDUCATIONAL AND RESEARCH INSTITUTIONS			
Understanding			
24	Have local educational institutions *(schools, colleges and universities)* organized renewable energy information sessions for their own students and teachers/ professors?		
25	Have they been involved in offering information sessions for the general public, the business community and elected officials?		
Opportunity			
26	Does the college or university have a related course of study related to renewable energy?		
27	Does the college or university have a particular training program related to renewable energy?		
28	Can particular teachers or professors be identified that have expertise in an areas related to renewable energy?		
29	If no local college or university exists, does the community have close links with colleges or universities close by that could assist with community understanding and issue exploration?		

B.3

COMMUNITY CAPACITY

This Checklist is meant to help the community to ensure that it is well-organized and ready to consider renewable energy project development proposals. At this stage the community may not yet have been approached by an outside investor or may not have any specific renewable energy initiative that it is considering.

The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
ORGANIZATIONAL CAPACITY			
Economic Development Structure			
1	Is the Economic Development Committee familiar with the basics of renewable energy?		
2	Does the Economic Development Coordinator have a working knowledge of renewable energy and know where to get further information?		
3	Does the community have a series of partners in place in both the public and private sectors that would be of assistance in considering renewable energy projects?		
4	Does the community have a set of template documents for project development such as a Memorandum of Understanding (MOU), Letters of Support, and Contracts etc? Most renewable energy projects will start with a MOU.		
Community Development Strategy			
5	Does the community have an up-to-date community development strategy i.e. strategic plan or similar?		
6	Has the community prepared a profile of the energy industry and businesses in the area?		
7	Has the community prepared an energy use profile? This refers to how much energy is used in the community and by whom.		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
ORGANIZATIONAL CAPACITY (cont'd)			
Business Support Programs			
8	Does the community have active programs to encourage and support existing and new businesses?		
9	Does it have a business incubator?		
10	Has the community undertaken a formal Business Retention and Expansion Study?		
LAND USE AND AVAILABILITY			
Planning Process for Development			
11	Is the Development Plan up-to-date?		
12	Does the Zoning By-law designate an adequate supply of commercial and industrially-zoned land? Land requirements will vary by project type.		
13	Are designations general enough not to require an amendment to accommodate most development proposals *(to Development Plan and/or Land-use By-law)*?		
14	Do you have a flow-chart outlining the steps in land use planning and development approvals process?		
15	Do you have a list of application fees, associated charges, imposts and levies?		
16	Does the Official Plan have associated Geographic Information System (GIS) mapping?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
LAND USE AND AVAILABILITY			
Inventories			
17	Do you have an inventory of available industrial public and private lands?		
18	Do you have an inventory of vacant industrial buildings?		
Industrial Park			
19	Do you have an industrial park that might be suitable for renewable energy projects?		
20	Does the park have site restrictions and covenants that might exclude some types of renewable energy projects?		
21	Has an environmental assessment been completed for the park?		
Other sites			
22	Have you identified potentially available sites in and around your community that could be suitable for renewable energy projects i.e. wind turbine sites, solar farms etc?		
23	Are you familiar with the Canadian wind and solar maps to help determine the suitability of your area for related projects? See wwww.windatlas.ca and solar http://glfc.cfsnet.nfis.org		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
UTILITIES			
Water, sewer and waste			
24	Does the community have sufficient excess water capacity to accommodate new development, particularly some renewable energy projects that might need access to large amounts of water?		
25	Does the community have sufficient sewage treatment capacity to accommodate new development? Is there potential for expansion?		
26	Does the community have adequate waste-disposal facilities?		
Access to the electricity grid			
27	Do you have the necessary information of transmission line configurations, sub-stations and line voltage?		
28	Does the grid have capacity for further project hook-ups? Has the capacity been officially verified with the Alberta Electrical System Operator (AESO)?		
29	What is the potential of line upgrades and will that create more capacity for new hook-ups?		
30	Have you verified the service costs for companies to access the grid and to distribute power?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
TRANSPORTATION AND COMMUNICATIONS			
Transportation			
31	Are the highways serving the community adequate for most manufacturing and distribution operations i.e. height, width and weight restrictions?		
32	Are there adequate common carrier trucking services?		
33	Do active rail lines service the community?		
34	Do you know the shipping times to the main distribution centers, hubs and ocean ports?		
35	Is your community within one hour driving time of an airport with scheduled commercial service?		
Communication			
36	Does your community have broadband service?		
RENEWABLE ENERGY FEEDSTOCKS FOR BIOENERGY			
Wood			
37	Do you have forest biomass resources available in the area of your community?		
38	If so, do you have an inventory of potential available resources?		
39	If you do not have an inventory, is it possible to identify the forest product companies who are forest licence holders and who may have available biomass or who may be willing to partner with a bioenergy project developer?		
40	Do you have wood processing companies who may have wood residues available i.e. lumber mill, flooring plant etc.? Do you know the quantities?		
41	Do you separate construction wood and other wood waste at your landfill? Do you know the quantities?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
RENEWABLE ENERGY FEEDSTOCKS FOR BIOENERGY			
Agriculture			
42	Do you have agriculture-related biomass resources *(solid and liquid)* available in the area of your community i.e. farms, feedlots?		
43	If so, do you have an inventory of potential available biomass resources?		
44	If you do not have an inventory, is it possible to identify the major agriculture sector operators who may have available feedstocks for bioenergy development?		
45	Has any interest been shown in your community for growing specific renewable energy crops?		
HUMAN RESOURCES			
Management and Professional			
46	Do you have an inventory of companies and individuals in your community or region who could provide project management services, engineering services, architectural services, legal services and other professional services for renewable energy projects?		
47	Do you have a complete and up-to-date labour force profile *(wages and benefits, supply and occupational categories, skills, latest employment data, employment forecasts)*?		
48	Do you have a complete and up-to-date list of educational institutions *(local or area)* or others who are able to supply training relevant to renewable energy development?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
RENEWABLE ENERGY FEEDSTOCKS FOR BIOENERGY			
Agriculture			
42	Do you have agriculture-related biomass resources *(solid and liquid)* available in the area of your community i.e. farms, feedlots?		
43	If so, do you have an inventory of potential available biomass resources?		
44	If you do not have an inventory, is it possible to identify the major agriculture sector operators who may have available feedstocks for bioenergy development?		
45	Has any interest been shown in your community for growing specific renewable energy crops?		
HUMAN RESOURCES			
Management and Professional			
46	Do you have an inventory of companies and individuals in your community or region who could provide project management services, engineering services, architectural services, legal services and other professional services for renewable energy projects?		
47	Do you have a complete and up-to-date labour force profile *(wages and benefits, supply and occupational categories, skills, latest employment data, employment forecasts)*?		
48	Do you have a complete and up-to-date list of educational institutions *(local or area)* or others who are able to supply training relevant to renewable energy development?		

ENVIRONMENTAL AND SOCIAL IMPACTS

This Checklist is meant to help the community ensure that in planning for renewable energy development the potential environmental and social impacts on the community have been considered. This checklist draws on the work of the United Nations Environmental Program (UNEP) in developing environmental and social risk assessment for renewable energy projects. As UNEP states, *"Although most renewable energy technologies are environmentally sound in theory, all of them can have negative impacts on the environment if poorly planned."* The fundamental steps in environmental and social due diligence is:

- Assess the risk
- Determine if risk mitigation measures are possible
- Determine the costs for managing the risk
- Monitor the risk management

The checklist is presented in the form of risks that can occur with particular technologies. At this stage, the question for the community is whether the type of risk is generally understood and whether you know where to access the expertise to consider any potential risk if it is identified. The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Expertise" if additional technical expertise may be needed.

	ISSUES FOR CONSIDERATION	EXPERTISE?
EFFLUENT EMISSIONS, ON-SITE CONTAMINATION, HAZARDOUS MATERIALS ISSUES		
Emissions		
1	Methane emissions *(biomass storage)*	
2	CO_2 emissions through conversion stacks	
3	Emissions of nitrogen oxide (NOx), sulphur dioxide (SO_2), particulates and volatile organic compounds (VOC) – related to co-firing, direct combustion and gasification	
4	Non-condensible gas emissions	
Effluents		
5	Solid waste *(ash)* – from biomass combustion	
6	Disposal of drilling effluents – deep geothermal	

	ISSUES FOR CONSIDERATION	EXPERTISE?
EFFLUENT EMISSIONS, ON-SITE CONTAMINATION, HAZARDOUS MATERIALS ISSUES (cont'd)		
Water Use		
7	Management of wastewater used for cooling or effluent treatment	
8	Management of any discharge water for ecological impacts	
BIODIVERSITY PROTECTION ISSUES		
Biomass related		
9	Removal of source of nutrients for the forest	
10	Possible soil erosion or compaction	
11	Harvesting and storage methods	
12	Potential impact on flora and fauna at plant sites and adjoining sites	
Use of water		
13	Disruption of local watersheds due to water intake	
WORKER HEALTH AND SAFETY		
14	Accidents due to emissions	
15	Accidents during construction	
16	Accidents relating from energy generation activity	
17	General need for emergency preparedness	

	ISSUES FOR CONSIDERATION	EXPERTISE?
EFFLUENT EMISSIONS, ON-SITE CONTAMINATION, HAZARDOUS MATERIALS ISSUES (cont'd)		
Biomass		
18	Possible pathogen release *(waste storage)*	
19	Bad odour from animal waste storage	
All Renewables		
20	Visual intrusion	
21	Groundwater pollution	
22	Depletion of local water resources	
23	Noise emissions	
24	Land use – project siting, competing uses	

B.5

INVESTMENT READINESS

The Investment Readiness Checklist builds upon the previous checklists and is the final checklist for the community in ensuring that the necessary preparations have been made to entertain (or initiate) specific proposals for renewable energy projects.

- A number of key components for successful investment attraction can be identified:
- Attracting investment based on community strength
- Optimizing the municipality's public resources
- Developing supply chain and multiplier-effect linkages
- Establishing and taking advantage of cluster-related synergies
- Investment in human capital

The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
STRENGTHS AND WEAKNESSES (Checklist 1)			
1	Is the Community Development Strategy now a formal document with specific references to renewable energy? Have you determined which types of renewable energy projects you want to attract or develop? Has industry provided input to the Strategy?		
COMMUNITY RECEPTIVENESS (Checklist 2)			
2	Have all of the relevant community groups and constituents now had a chance to understand the opportunities of renewable energy development and also had a chance to voice any concerns?		
3	In particular, are municipal leaders and the business community committed and well-organized to promote and follow-up on leads for renewable energy project development and investment?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
COMMUNITY CAPACITY (Checklist 3)			
4	Are all of the necessary business support programs in place to assist new renewable energy companies to establish and to assist existing businesses to take full advantage of supply opportunities presented?		
5	Has the Municipal Development Plan, Land Use By-law now been reviewed to ensure receptiveness to renewable energy projects?		
6	Are all of the approval steps and fees clearly laid out for a potential investor?		
7	Are suitable land and building inventories in place?		
8	Have location sites in the industrial park and elsewhere been "pre-screened" for potential renewable energy projects?		
9	Have all of the potential utility issues been reviewed and the necessary information gathered to assist potential investors?		
10	Have all relevant issues with respect to transportation and communication been addressed?		
11	Do you have a set of legal templates developed for renewable energy projects, memorandum of understanding (MOU), letters of support etc.?		
12	Is your public and private network of partners and potential partners in place *(or at least identified)*?		
13	Has the community done as much as it can to identify potential biomass feedstocks from forests and agricultural lands?		
14	Have human resource issues relevant to renewable energy projects been reviewed and addressed?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
ENVIRONMENTAL AND SOCIAL ISSUES (Checklist 4)			
15	Has the community reviewed all of the potential environmental and social issues that may need to be considered relevant to renewable energy projects and has available expertise been identified?		
BEYOND THE BASICS OF INVESTMENT READINESS			
Active Business Recruitment			
16	Do you have a formal and funded marketing plan and program to recruit new renewable energy investors to your community		
Local Investment Capacity			
17	Has your community undertaken specific actions to determine the local financial capacity to initiate renewable energy projects or for local businesses to be a partner or investor in potential projects?		
18	Have you ensured that the attitude of local banks and their head offices is positive to investment in renewable E nergy?		
Local Renewable Energy Team			
19	Does your community have a definite team in place to receive and screen renewable energy opportunities when projects are presented? Does it include all of the necessary levels of expertise?		
20	Does the team have an analysis process in place to determine the potential economic, environmental and social impact of any proposed project?		
21	Does the team have a suitable budget to undertake any required due diligence on any proposed project?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
Integrated Community Energy Solutions (ICES)			
22	While not yet mainstream in Canadian communities, applying ICES can demonstrate to residents, businesses and investors how seriously a community takes energy planning. Quality Urban Energy Systems of Tomorrow (QUEST) and the Council of Energy Ministers of Canada offers a framework for communities of all sizes to approach energy supply and demand planning in an integrated and holistic way to achieve a maximum reduction in GHG emissions. Is ICES something your community might want to consider? See www.questcanada.org		

C.1

DEVELOPMENT VIABILITY

This Checklist refers to the information that you should know concerning any renewable energy project developer that is proposing an initiative in your community or region. It is very important to know that the company you are dealing with is reputable, secure and can actually accomplish project implementation.

The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
DEVELOPER'S CORPORATE INFORMATION			
1	Is the Community Development Strategy now a formal document with specific references to renewable energy? Have you determined which types of renewable energy projects you want to attract or develop? Has industry provided input to the Strategy?		
2	Do you know where the company is incorporated? In Canada? Elsewhere? When was it incorporated?		
3	Do you have the names and contact information for all of the Directors of the company?		
4	Do you know the type of company that is proposing the project? Is it a pre-developer who has partnerships with other companies during the development phase?		
5	Do you know the linkages of this company? Parent company? Subsidiaries? Partnerships?		
6	Do you know how many employees are in the developer's company? Compared with a year ago?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
DEVELOPER'S PROJECT HISTORY			
7	Do you know the other projects – similar to the one that is being proposed for your community – that the developer has developed or co-developed? *(Locations, numbers, size etc.)*		
8	Do you have reference contacts for these other projects? Do you know if they are still operating?		
9	If the developer has sold previous projects, do you know at what stage they sold? Soon as built? After one year operation? After multi-year operation?		
10	Do you know whether the developer is pursuing other similar projects at the same time they are approaching you?		
11	If the developer is pursuing other projects, do you know the priority ranking of the project being proposed in your community?		
12	Do you know if the developer has recently delayed other projects?		
THE PROJECT			
13	Do you fully understand the project that is being proposed? Electricity generation? Combined heat and power? Biofuels?		
14	Do you understand whether this is a "greenfield" project *(new production facility)* or a "brownfield" project *(enhancement of existing facility)*?		
15	Do you have a timeline of when the project would be operational in your community? *(number of years to develop)*		
16	Do you understand the size of the project? In terms of annual production *(MW electrical, MW heat, litres, etc.)*? In terms of investment required?		
17	Do you understand whether the project is phased? *(starting with one project and then developing further)*		
18	Do you understand the technology that the developer is proposing to use? [See Technology Checklist]		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
THE PROJECT cont'd			
19	Does the project require the municipality to commit to new services or infrastructure?		
20	Is the project conditional on being able to source the necessary feedstocks?		
PROJECT FINANCING			
21	Do you know the principle investors in the developer's company for this project?		
22	Do you understand how the operations of the developer's company are being financed? (private backing, IPO, institutional backing etc.)		
23	Do you understand how the project in your community will be financed? (Pre-development, construction and operation)		
24	Is the project conditional on receiving government incentives? What percentage of the total financing is being sought from incentives? Is it realistic?		
TYPES OF AGREEMENT			
25	Do you understand the type of agreement that the developer is proposing to the local project partners and the municipality?		
26	Have you been given a template agreement that has been used in other similar projects? How does this compare with your own template package for MOU's, contracts etc.?		
27	Are any restrictions being proposed in the agreement that could hinder the overall renewable energy development in the community?		
28	Does the developer fully understand the municipal and provincial permitting regulations and the associated charges? Are these reflected in the agreement?		
VETTING WITH PROVINCIAL AND FEDERAL GOVERNMENT AGENCIES			
29	Have you checked whether the developer is known to agencies of the provincial and federal governments? What is the developer's reputation with these authorities?		

TECHNOLOGY

This Checklist refers to the information that you should know concerning the technology that the developer is proposing to use. Four basic levels of technology readiness can be defined:

1. Research and development including pilot plants (not full scale).
2. Demonstration of full-scale projects.
3. Early deployment in which additional full-scale projects are being initiated and the technology is being refined.
4. Commercial level where costs and risks are well understood and fully mature

The technology will be specific to the type of project, as outlined in the list of Types of Energy Projects.

The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
TECHNOLOGY READINESS			
1	Can you identify the type of project *(from the list of Types of Renewable Energy Projects)*?		
2	Can you identify the level of technology readiness as one of the four referenced above? Ask the developer to specify.		
3	If the proposed technology is not fully commercial do you have the expertise available to understand where it fits in the list and the risks of the technology not proving viable?		
4	Are you sure that the developer has a license *(rights)* to use the technology that is being proposed? Ask for written proof.		
5	Does the developer fully understand the permitting requirements related to the technology and plant proposed?		
6	Have you verified the safety level of the technology proposed *(i.e. with some pellet and/or bioenergy plants risks of fire and explosion)*?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
OUTPUT OF THE TECHNOLOGY **Can you identify the proposed production level of the technology?**			
7	• Electrical power production measured in electrical Megawatts (MWe).		
8	• Thermal power production *(heat)* measured in thermal megawatts (MWt)		
9	• Biofuel production measured in millions of liters per year		
10	• Types and volumes of emissions		
11	• Types and level of noise		
TECHNOLOGY REQUIREMENTS **Can you identify the following parameters and requirements?**			
12	• Type of construction, fixed or transportable		
13	• Footprint of infrastructure and operations		
14	• Land requirements		
15	• Energy requirements for the operation		
16	• Water and sewer requirements for the operation		
17	• Other utility requirements for the operation		
18	• Transportation and communication requirements		
OPERATIONAL PERFORMANCE			
19	Has the developer provided you with references of other plants using the proposed technology in the same production size range? Have you checked those references? Have you visited any of the referenced locations?		
20	What is the expected efficiency of the technology *(rated capacity versus actual proposed production)*?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
OPERATIONAL PERFORMANCE (cont'd)			
21	Has the developer indicated the expected maintenance schedule for the technology?		
22	Has the developer indicated the skill levels needed for the technology and any training requirements?		
COMPONENTS SUPPLY			
23	Has the developer indicated the key component suppliers for the technology? Are they known to you or your expert advisors?		
24	Does the developer expect delays in the supply chain? (e.g. long waiting times for the supply of wind turbines)		
25	Does the supplier understand the need for suppliers – particularly those external to North America – to comply with Canadian certification standards?		
26	Have you and the developer identified the components that could be supplied locally?		
FEEDSTOCK SUPPLY (for bioenergy projects only)			
27	Has the developer indicated to you the specific feedstock requirements of the technology?		
28	What is the quantity of biomass required? This is usually measured "in dry tons per day"? Wet tons would be about double the amount of dry tons.		
29	What are the moisture limitations of the biomass for the technology proposed?		
30	What are the particle size limitations of the biomass for the technology proposed?		
31	Has the biomass that can be supplied been tested to ensure its compatibility with the technology?		
32	Has the developer indicated the upper cost limit of the biomass that the technology and project size will support? Is this realistic?		
33	Does the developer have contracts or licences in place for the supply of the feedstock? What is the duration of the contracts?		

C.3

COMMUNITY BENEFIT AND DEVELOPMENT BUSINESS PLAN

This Checklist builds on the Developer Viability and the Technology checklists to assist the community in the overall project consideration with respect to the anticipated benefits to the community and the soundness of the developer's business plan.

The questions below are intended to provide some assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
COMMUNITY BENEFIT			
1	Does the project fit with the community's strategic plan? Does it require any changes to the plan?		
2	Does the project fit with existing and planned infrastructure? Does it require any particular changes or upgrades? Has the cost been quantified?		
	Have you considered and quantified the following community costs and benefits?		
3	• Overall economic and financial impact		
4	• Impact on tax base and revenues		
5	• Job creation and retention		
6	• Linkages to local businesses		
7	• Ability to attract further associated development		
8	• Contribution to long-term sustainability		
9	• Potential increased costs to the community for protection services, human services and planning		
10	Have you provided for full community information and consultation on the proposed project and addressed all concerns?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
DEVELOPER'S BUSINESS PLAN - Technical Feasibility			
11	Are you convinced of the technical feasibility of the project?		
12	Have you sought expert advice on the technical feasibility?		
DEVELOPER'S BUSINESS PLAN - Management Feasibility			
13	Are you convinced that the developer and any identified partners will be able to successfully implement the project through all of its phases?		
DEVELOPER'S BUSINESS PLAN - Economic Feasibility			
14	Are you convinced that the developer and any identified partners will be able to successfully implement the project through all of its phases?		
DEVELOPER'S BUSINESS PLAN - Market Feasibility			
15	Are you convinced that the developer has taken all necessary measures to ensure a sustainable market for the output of the project?		
16	Have you sought independent advice on the market and its longer-term development?		
17	If electrical power is to be produced, are all of the necessary agreements, approvals, permits and contracts in place for providing electricity to the grid?		
DEVELOPER'S BUSINESS PLAN - Financial Feasibility			
18	Are you convinced that, based on the above elements of the Developer's Business Plan, that all of the necessary capital and financing is in place to take the project from planning, to construction, to operation?		
19	Have you sought independent advice of the project's financial feasibility?		
DEVELOPER'S BUSINESS PLAN - Environmental Feasibility			
20	Are you convinced that the Developer's Business Plan has addressed all environmental issues, has acquired the necessary related permits and has committed to put in place all necessary mitigation and monitoring measures?		
21	Do you have expertise available to ensure the developer's environmental compliance as the project moves forward?		

C.4

REALITY CHECK

This Checklist of ten direct questions is meant to ensure that your community is engaged in a particular project development on the basis of "reality" and not "wishful thinking" or being taken in by the charms of a "snake-oil salesman".

The questions below are intended to provide assistance but are not necessarily all of the questions that could or should be considered in specific community situations. Answer each question with a "yes" or "no" and check the box "Action Needed" if an issue may require further action.

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
1	Have you done extensive research on the company and the technology and sought the advice of experts where you do not have the answers?		
2	Have you and your experts reviewed technical patent literature, business literature, market literature, financial statements and business plans provided by the developer?		
3	Have you taken all the time required for due diligence and avoided "quick deals" for fear that the developer might go elsewhere?		
4	In any Memorandum of Understanding or contractual agreements, have you allowed for equitable exit clauses? Has your legal advisor been involved?		
5	If something sounds too good to be true, it probably is. Have you erred on the side of caution but while taking a "calculated" risk?		
6	Have you gone beyond the "glossy" literature and web-sites of potential developers? Developer media releases are not a substitute for proper due diligence.		
7	If a developer has approached you and appears serious, have you asked for a bond or deposit to demonstrate commitment?		

	QUESTIONS FOR CONSIDERATION	YES/NO?	ACTION NEEDED?
8	In the process with the developer, have you documented all meetings and decisions?		
9	Can you honestly say that you have not been "sweet talked into promises of prosperity" for your community but have relied on facts and proper business practices?		
10	Have you provided for full community information and consultation on the proposed project and addressed all concerns?		